DOE Guide on Integration of Multiple Hazard Analysis Requirements and Activities

PRELIMINARY DRAFT

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Table of Contents

1.0 Introduction

During Fiscal Year 2001, a Chemical Safety Topical Committee (CSTC) formed a team to evaluate possible methods for integrating chemical hazard analysis activities with radiological, emergency preparedness, environment and other potentially overlapping hazard analysis activities. The group identified and reviewed hazard analysis requirements and issues, collected numerous sources of good practices information and evaluated possible methods for integrating hazard analysis activities.

This guide captures many of the CSTC Hazard Analysis Team's insights based on interactions with industry and DOE field personnel. Specifically, this guide provides an objective evaluation of current DOE directives and federal regulations, highlights opportunities for integrating hazard analysis activities, and provides good practices that can improve effectiveness of hazard analysis and improve cost performance.

The concepts presented in this guide are supportive of an integrated safety management system as addressed in DOE G 450.1-4, *Integrated Safety Management System Guide*, and can be applied to nuclear or hazardous non-nuclear facilities that are either operating, shutdown, or actively conducting facility disposition activities. The underlying premise is that hazard analysis is applied to all levels of work activities and includes an evaluation of how hazards can impact workers, the public and the environment.

2.0 Comparison of Hazard Analysis Requirements

DOE contractors conduct multiple hazard analysis activities in accordance with various DOE orders, rules and federal regulations. The Hazard Analysis Team worked closely with another CSTC Team (Consolidated User Safety and Health Requirements) who identified numerous requirements with a direct reference to hazard identification, hazard analysis, hazard evaluation, hazard assessment, accident analysis, risk analysis or risk assessment. These requirements were found in the following primary source documents:

- 10 CFR 830, Subpart B, "Nuclear Safety Management"
- 10 CFR 835, "Occupational Radiation Protection"
- 10 CFR 850, "Chronic Beryllium Disease Prevention Program"
- 10 CFR 1021, "National Environmental Policy Act Implementing Procedures"
- 29 CFR 1910.119 and 1926.54, "Process Safety Management"
- 29 CFR 1910.120 and 1926.55, "Hazardous Waste Operations and Emergency Response"
- 40 CFR 68, "Chemical Accident Prevention Provisions"
- 40 CFR Parts 1500-1508, "Chapter V-Council on Environmental Quality"
- DOE O 151.1, "Comprehensive Emergency Management System"
- DOE 420.1, "Facility Safety"
- DOE O 440.1A, "Worker Protection Management"
- Various other OSHA regulations as found in 29 CFR 1910 and 1926

Many of these requirements share the same basic intent, which is to identify and analyze potential dangers to employees, the public and environment so that effective controls can be established to minimize or prevent adverse impacts. A comparison of the purpose and expectations for each of these requirement sources is summarized in Appendix A.

Each requirement source has a different focus such as emergency management, nuclear safety, chemical safety, or worker protection. However, common objectives are found among certain groups of requirements that can be characterized as addressing either (1) facility-level safety, (2) task-level safety, or (3) protection against a specific hazard (e.g., beryllium, fire, criticality, natural phenomena). All of the identified hazard analysis requirements addressed in this guide fit into one of these three areas. The relationship of these groups and various requirements is shown in Figure 1 and described in Section 2.

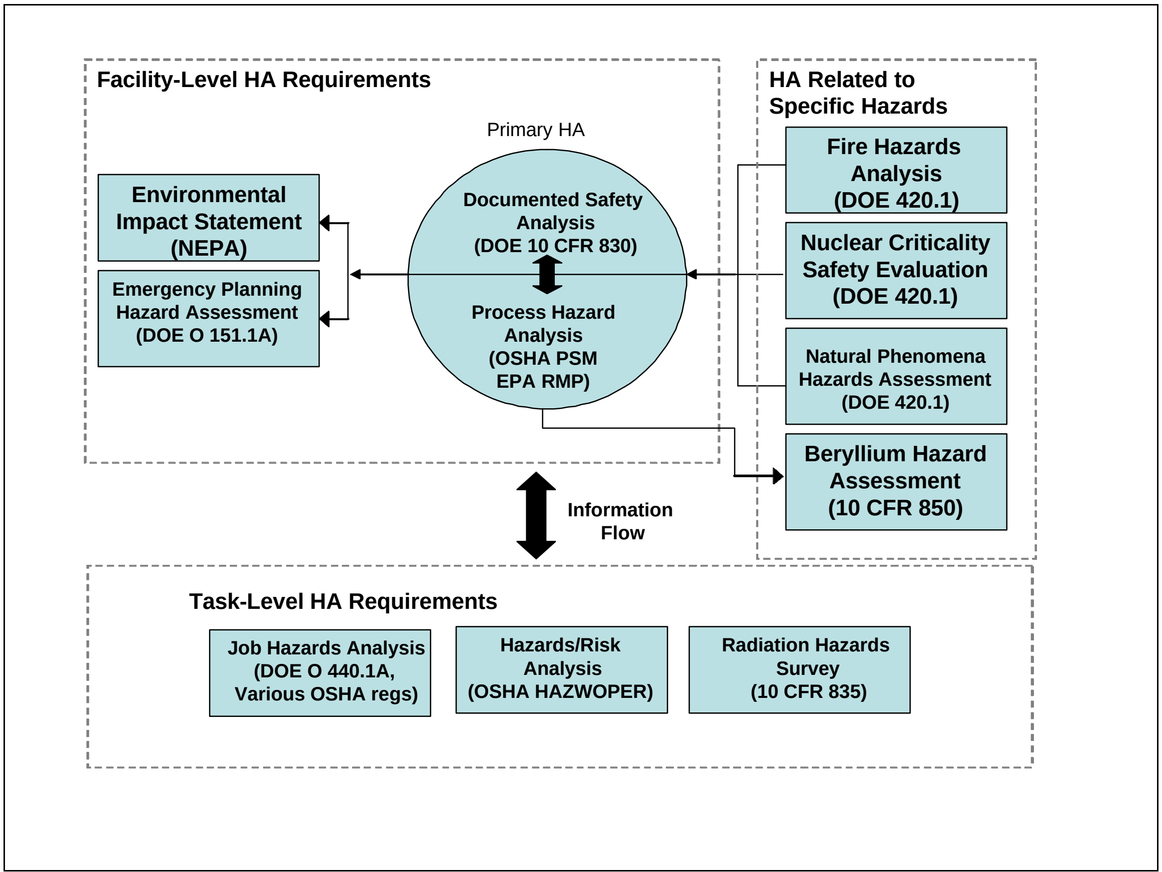

Figure 1. Common Groupings and Relationships of Hazard Analysis Requirements

2.1 Facility-Level Hazard Analysis Requirements

Certain hazard analysis requirements are concerned with the potential consequences that a **facility's** operation can have on the workers, public or the surrounding environment. These requirements involve an evaluation of the hazards and consequences associated with a potential release of hazardous or radiological materials from processing lines, storage containers, tanks, building confinement, or other facility systems. This "facility-level" emphasis is found in the following sources:

- Chemical Process Hazard Analysis (40 CFR 68, "Chemical Accident Prevention Provisions," and 29 CFR 1910.119 [and 1926.54], "Process Safety Management")
- Nuclear facility safety analysis (10 CFR 830, Subpart B, "Nuclear Safety Management")
- Emergency Preparedness Hazard Assessment (DOE O 151.1, "Comprehensive Emergency Management System", and
- Environmental Impact Statements (40 CFR Parts 1500-1508, "Chapter V-Council on

Environmental Quality")

Chemical/Nuclear Hazard Analysis. Chemical process hazard analysis (PrHA) is required by both OSHA and EPA for facilities exceeding established hazardous chemical threshold quantities. These two chemical safety regulations have essentially the same hazards analysis requirements (i.e., scope, techniques, and required documentation). Also, both regulations share similarity to 10 CFR 830, Subpart B which requires that a documented safety analysis (DSA) be prepared at DOE nuclear facilities. The PrHA and the DSA serve as the primary analysis of facility-level hazards, and both involve (1) identification of hazardous material or radionuclide inventories; (2) implementation of formal hazard analysis techniques that are commensurate with facility complexity; (3) identification of systems and equipment vital to safety; (4) formal documentation of findings; and (5) periodic updates of hazard analysis information.

This overlap is recognized in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, which points out that many of the requirements addressed in the OSHA PSM standard are directly parallel to DOE nuclear safety analysis topics. **Because of the apparent similarities, it is reasonable to conduct one integrated hazard analysis at nuclear facilities in which all three regulations are required.** However, DOE goes beyond the PrHA requirements of OSHA/EPA by requiring DSAs to evaluate potential consequences and estimation of the likelihood of accidents, both with and without the aid of protective features (e.g., physical barriers, engineered controls, etc). **Since a DSA is more encompassing, it should therefore be used as the primary vehicle for conveying the results of an integrated chemical/nuclear hazard analysis.**

Emergency Preparedness Hazard Assessment. The purpose of an Emergency Preparedness Hazard Assessment (EPHA) is to help define a facility's emergency management plan and the associated Emergency Planning Zone. The EPHA requires an evaluation of traditionally defined "accidents" as well as those arising from external causes and malevolent acts. An analysis of challenges to and failures of barriers protecting hazardous or radioactive materials is used to determine the events and conditions that could release each hazardous material and the magnitudes of those possible releases.

An EPHA is required by DOE O 151.1A, *Comprehensive Emergency Management System*, for facilities exceeding certain chemical or radiological hazard thresholds. For hazardous chemicals, this includes the lowest of Threshold Quantities in 29 CFR 1910.119 or 40 CFR 68.130, or the Threshold Planning Quantities listed in 40 CFR 355. For chemicals not listed, the Reportable Quantities (RQs) for hazardous substances listed in 40 CFR 302.4 may be used. For radioactive materials, the limits are listed in 10 CFR 30.72, Schedule C.

Because of these thresholds, an EPHA is required for a broad set of facilities that encompass (1) nuclear facilities subject to 10 CFR 830, Subpart B; (2) chemically hazardous facilities subject to OSHA PSM and EPA Risk Management Program; and (3) other facilities not subject to these regulations but containing hazardous/radioactive materials exceeding emergency management thresholds. The first two cases present the primary opportunity for hazard analysis integration since they involve applicability of multiple hazard analysis requirements.

DOE G 151.1-1 V2, *Hazardous Survey and Hazards Assessments*, acknowledges similarities between the EPHA and safety analyses that are compliant with DOE Order 5480.23 (now 10 CFR 830, Subpart B). This includes the use of common baseline hazards information, equivalency of many accident initiators and similarity in consequence assessment models. This similarity also extends to some aspects of PrHA performed at chemically hazardous facilities. However, there are also additional features of the EPHA, such as consideration of malevolent acts, which goes beyond the scope of DSAs and PrHAs. Further, the EPHA involves the calculation of radiological and chemical releases in terms of distances beyond which protective action criteria [protective action guides (PAGs) and ERPGs] are exceeded.

Therefore, analysts are encouraged to use hazards analysis data and results from DSAs, or PrHAs in the case of a non-nuclear hazardous facility, as a primary basis for conducting EPHAs. This includes the use of baseline assumptions for material inventories (location, quantity and form), energy sources and accident initiators/scenarios needed in the EPHA to determine emergency management needs and establish emergency planning zones. **This will help minimize the efforts needed to complete an EPHA**.

Environmental Impact Statements. The National Environmental Policy Act (NEPA) 1969 [Section 102(2)(c) in 40 CFR 1502] requires that environmental impacts be evaluated of proposed activities that could harm the environment. An Environmental Impact Statement (EIS) is the vehicle for this analysis and is required by NEPA for certain classes of DOE activities as defined in 10 CFR 1021, *National Environmental Policy Act Implementing Procedures* (see Subpart D, Appendix D). Some examples of activities requiring an EIS include siting, construction, operation and decommissioning of nuclear fuel reprocessing facilities, waste disposal facilities, and incinerators.

For each of the alternatives considered in an EIS, an analysis of facility accidents must be prepared. **This should involve a review of available hazard and accident analysis information from previous safety analysis documents, environmental assessment documents, or other available risk assessments such as a PrHA**. Data that is common to these analyses and the EIS includes hazard assumptions such as source term estimates, accident initiators, and release scenarios. However, the EIS is somewhat different in the methods and targets chosen to evaluate potential consequences. For example, an EIS has a broad focus on impacts to the "human environment" that involves consideration of long-term health and socio-economic impacts to populations (i.e., potential cancer fatality risks to workers and the public) from events such as groundwater contamination, as well as consideration of impacts to other natural resources. DSA and PrHA efforts are focused primarily on acute effects to workers, public and environment (primarily from airborne exposure). **In spite of these differences, many of the basic assumptions supporting EIS-related hazard identification, hazard analysis, and accident analysis activities are consistent with nuclear safety analysis or chemical PrHA activities.**

2.2 Requirements Related to Analysis of Specific Types of Hazards

A second group of hazard analysis activities can be characterized as having in common a focus on specific types of hazards. Hazard analyses that fall into this category include the following:

- Fire Hazards Analysis (DOE O 420.1)
- Nuclear Criticality Safety Evaluation (DOE O 420.1)
- Natural Phenomena Hazards Assessment (DOE O 420.1)
- Beryllium Hazards Assessment (10 CFR 850)

Since each of these analyses are focused on a generically different hazard, there is little apparent overlap among requirements in this group. However, there are some basic links among these hazard analysis activities that should be considered, as well as a need for integration with nuclear safety analysis or PrHA activities.

Fire hazards analysis (FHA), is required for all nuclear facilities or facilities that present unique or significant fire risks. This involves a comprehensive evaluation of fire hazards, including postulation of fire accident scenarios and estimates of potential consequences (i.e., maximum credible fire loss). DOE O 420.1, *Facility Safety*, requires that conclusions of the FHA be integrated into safety analysis reports (or DSAs per 10 CRR830). The DOE Implementation Guide G-420.1/B-0 (G-440.1/E-0) addresses this integration as follows:

> "When both an FHA and a SAR are developed for a facility, the developmental effort should be coordinated to the maximum extent possible to avoid duplication of effort. It is recognized, however, that because an FHA is based on the premise that a fire will occur and considers fire safety issues (property loss and program discontinuity potential) that are not normally considered in the SAR, the conclusions of the FHA may be more conservative than would normally be developed by a SAR alone. Nevertheless, the FHA and its conclusions should be addressed in the facility SAR in such a manner as to reflect all relevant fire safety objectives as defined in Paragraph 4.2.0.1 of DOE 420.1 and Section 2 of Attachment 1 of DOE 440.1."

Although not stated, this same principle would apply to PrHA efforts at non-nuclear hazardous facilities that are subject to DOE 420.1

The Defense Nuclear Facilities Safety Board has noted several instances at DOE sites where FHAs are inconsistent with accident assumptions found in nuclear safety analysis (e.g., fire barriers were assumed where they weren't present). **FHAs should be coordinated and integrated through means such as teaming of fire safety personnel with hazard/accident analysts.** A white paper on this topic, which was prepared by members of the DOE fire safety community, is provided in Attachment 3.

Nuclear Criticality Safety Evaluation and Natural Phenomena Hazard Assesmsent. DOE O 420.1 also requires a Nuclear Criticality Safety Evaluation (NCSE) and a Natural Phenomena Hazard Assessment (NPH). An NCSE is an evaluation focused on facility piping, vessels and design features to identify the parameters, limits, and controls needed to prevent an inadvertent criticality. **While this activity is not duplicative of safety analysis efforts, coordination and integration is necessary. The NCSE provides important assumptions and conclusions that must be reflected within DSAs regarding the initiators for a criticality event, as well as the consequences.**

NPH assessments involve an assessment of the likelihood of future natural phenomena occurrences and the response of facility systems, structures and components to a design basis NPH event. The resulting information is used as important assumptions within safety analysis or PrHA to calculate accident scenarios and consequences. **Therefore, NPH assessments should be coordinated through teaming efforts with hazard/accident analysts.**

Beryllium Hazards Assessment. A hazards assessment is an integral part of a Chronic Beryllium Disease Prevention Program Plan as required by 10 CFR 850. This activity requires identification of the quantity and form of beryllium materials and their locations, as well as an assessment of possible beryllium exposures from planned activities. **Much of the hazards information needed to support this assessment may be available in existing safety analysis, PrHA documents, airborne monitoring data, or other previous hazard assessments conducted at a facility.**

2.3 Activity-Level Hazard Analysis Requirements

A third group of hazard analysis activities can be characterized as focusing on worker related hazards associated with specific job tasks. These include the following sources:

- Hazard and Risk Analysis of Hazardous Waste Cleanup Activities (29 CFR 1910.120 and 1926.55, “Hazardous Waste Operations and Emergency Response”)
- Job Safety and Hazard Analyses (DOE O 440.1A, “Worker Protection Management” and other OSHA regulations).
- Analysis of Occupational Radiation Hazards (10 CFR 835, “Occupational Radiation Protection”)

Each of the hazard analysis requirements reflected in this group are an integral part of work planning, which feeds into the preparation of hazardous and radiation work permits, Health and Safety Plans, Industrial Hygiene Plans and overall work packages and documentation. These activities have a different emphasis than facility-level hazard analysis, since they are primary focused on worker protection. As such, activity-level hazard analysis addresses the hazards associated with individual job functions and tasks.

In spite of these differences, there is an important link between facility and activity level hazard analysis requirements in terms of the flow of hazards information and data. Facility-level information and assumptions related to hazardous material inventory (e.g., quantity, form and location) feed into job hazards analysis in order to help identify the range of potential hazards a worker may encounter while carrying out his duties (e.g., valve maintenance on a high pressure liquid hazardous waste line). Conversely, assessment of work-related hazards from task level analysis may yield insights into hazards that aren’t adequately covered within facility-level analysis and as such may warrant further evaluation by a PrHA or DSA.

3.0 Good Practices

Good practices identified in this section are supportive of an integrated evaluation of hazards and when collectively implemented can improve effectiveness of hazard analysis and overall cost performance. These practices are based on observations by the CSTC working group and interactions with various DOE and industry organizations.

A discussion of each practice is provided, along with additional sources of information that can be consulted for further explanation.

3.1 Multi-Disciplinary Teams

Multi-disciplinary teams are needed to support all functions of an integrated safety management system, including hazard analysis. Teaming of safety and line management disciplines is an effective way to help reduce uncertainties and redundancy of analysis activities. A team can be used to perform various hazard analysis activities including identification of hazards and validation of facility assumptions, hazards screening, implementing hazard analysis techniques, establishment of controls, and preparation of safety documents.

The size and composition of the team will vary depending on the combination, magnitude, and type of hazards involved, and the facility life cycle phase and complexity. Subject matter experts may be needed on a part or full-time basis to support the HA activities. These may include disciplines such as criticality engineers, fire protection specialists, health physicists, structural engineers, industrial hygienists, etc. Table 1 provides examples of how to choose subject matter experts based on the type work activities or hazardous conditions present in the facility.

The cross-section of various team member disciplines participating in a hazard analysis effort should begin communicating early in the process. Ideally, this should occur during the initial stages of work planning. This will permit ample scoping and identification of safety and technical disciplines needed to participate in preliminary hazard analysis activities. This early involvement will facilitate an integrated effort in which common hazard assumptions can be formulated as a collective group.

Communication between team members should continue during the entire hazard analysis process to ensure that changes in work planning assumptions or new hazard discoveries will be appropriately evaluated.

Selection of team member should include workers for facility and task level analysis, especially during job hazards analysis (JHA). These individuals are a valuable source of facility knowledge, particularly when facility-operating records are sparse or not available. Additionally, workers bring skill of the craft perspectives to activities such as JHA. Worker input should be solicited regarding present facility configuration, hazard uncertainties, and clarifications on facility history not available through facility documents.

Work and Hazard Characteristics	Subject Matter Expert Support						
	S	IH	RAD	ENG	ENV	FP	CRIT
The activity presents a potential to release a hazardous substance to a space in a quantity sufficient to exceed IDLH conditions(e.g., O_2deficiency, release of toxic gases).		X					
The facility involves systems that contain flammable or combustible gases at positive pressure.	X	X				X	
Work involves uncharacterized or unknown chemical hazards (abandoned equipment, unlabeled containers).		X			X	X	
The work modifies or affects HVAC flow or local exhaust systems used to control exposures to radiological substances		X	X	X			
Will the work activity involve or generate wastes		X			X		
The work could potentially affect the capability of an engineered safety feature or administrative control to prevent or mitigate a criticality accident	X	X	X	X		X	X
Legend: CRIT-Criticality Safety ENG-Engineering (system or discipline) ENV-Environmental Engineer	FP-Fire Protection IH-Industrial Hygiene RAD-Radiological Control S-Industrial Safety						

Table 1. Sample Considerations for Selecting HA Team Participants

Sources of Information on Multi-Disciplinary Teams:

- DOE/EH-0506, Worker Involvement Lessons Learned and Good Practices from INEEL Facility Disposition Activities
- DOE/EH-0486, Integrating Safety and Health During Facility Disposition, with Lessons Learned from PUREX

3.2 Collection and Integration of Hazards Information

The OSHA PSM Rule requires that up-to-date chemical process safety information be collected and maintained before conducting a PrHA. Likewise, nuclear safety information and process knowledge is required in order to support safety analysis activities. The approach to collecting hazards information should be inclusive of all hazard types in order to support a balanced evaluation of hazards and necessary controls.

An integrated approach to information collection is a requirement for commercial nuclear operations subject to 10 CFR 70. This requires that process safety information be collected to support an integrated safety analysis and should be inclusive of information pertaining to the hazards of the materials used or produced in the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process. Although not a requirement for DOE operations, this approach provides a good model that is also consistent with OSHA PSM requirements and DOE nuclear safety requirements

Hazardous or Radioactive Material Data

Information about radiological materials and hazardous chemicals used in a process must be comprehensive enough for an accurate assessment of fire and explosion characteristics, reactivity hazards, criticality hazards, corrosion or other adverse effects on process equipment and various other safety and health hazards. Information should include, as appropriate: (1) toxicity information; (2) permissible exposure limits; (3) physical data such as boiling point, freezing point, liquid/vapor densities, vapor pressure, flash point, auto ignition temperature, flammability limits (LFL and UFL), solubility, appearance, and odor; (4) reactivity data, including potential for ignition or explosion; (5) corrosivity data, including effects on metals, building materials, and organic tissues; (6) identified incompatibilities and dangerous contaminants; and (7) thermal data (heat of reaction, heat of combustion); and (8) quantities, locations and forms or both hazardous and radioactive materials. Where applicable, process chemistry information should also be included about potential runaway reactions and overpressure hazards and hazards arising from the inadvertent mixing of incompatible chemicals.

Process Technology Data

Where facility processing of radiological or hazardous chemicals is conducted, process information should be collected and should include at least: (1) block flow diagrams; (2) process chemistry; (3) established criteria for maximum inventory levels for process chemicals or radioactive materials; (4) process limits that, when exceeded, are considered an upset condition; and (5) qualitative estimates of the consequences of deviations that could occur if established process limits are exceeded.

Facility Process Equipment Information

Facility and process equipment information should include at least: (1) materials of construction; (2) piping and instrumentation diagrams (P&IDs); (3) electrical classification; (4) relief system design and design basis; (5) ventilation system design; (6) design codes and standards; (7) material and energy balances for processes; (8) safety systems; (9) major energy sources; and (10) interfaces with other facilities.

Sources of Information on Collecting Hazards Information:

- 10 CFR 70.62 (Domestic Licensing of Special Nuclear Material)
- NUREG-1520, Chapter 3, Integrated Safety Analysis and ISA Summary (http://techconf.llnl.gov/cgi-bin/downloader/Part_70_lib/073-0161.pdf)
- DOE HDBK-1100-96, Chemical Process Hazard Analysis
- 29 CFR 1910.119, Process Safety Management

3.3 Screening of Multiple Hazard Types

Hazard screening is a useful process that can help pinpoint the presence of certain hazard types that don't require comprehensive or formalized analysis in order to develop a control strategy. Many DOE sites use screening processes in conjunction with collection of hazard baseline information in order to make decisions on the rigor of hazard analysis, safety documentation that may be required and the processes required for work authorization. Screening is also routinely incorporated into work planning activities through the use of checklists as a part of job hazards analysis.

In most cases, hazard screening helps to idenitfy standard industrial hazards (SIH) that are routinely encountered and/or accepted by the public in everyday life. These include hazards that are (1) are well understood, (2) have adequate safety guidance relative to their use, and (3) are adequately controlled by OHSA regulations or one or more consensus standards. Examples of SIHs include small quantities of radionuclides or chemicals and occupational hazards typically associated with mechanical presses, machine shops, fork lifts, and heavy equipment operation.

The key to an effective screening process is that it encompasses a comprehensive listing of multiple hazard types and has a basis linked to regulatory requirements. A composite screening process is provided in Table 2, based on observed practices from various DOE sites. It is intended for information purposes only.

While screenings are useful tools, users should bear in mind that SIHs must still be considered as initiators for accidents involving other hazards. For example, flammable materials may be screened out as an SIH, however, if the flammable materials could potentially cause a fire that releases toxic materials, the flammable materials must be considered as a potential initiator for a toxic material release. Additionally, SIHs can result in significant injury to workers and, although well understood, may need to be further analyzed by a JHA.

Table 2. Sample Criteria for Determining Standard Industrial Hazards (i.e., hazards not meeting definitions below)

Radioactive material	Any radioisotope meeting or exceeding the Table A1, DOE-STD-1027-92 TQ criteria; or exceeding the Appendix B, 40 CFR 302 RQ criteria. The inventory/RQ or Inventory/TQ ratios should be added when making this evaluation.
Radioactive surface contamination	Measurements of fixed, removable, or both exceed values in 10 CFR835
Radioactive waste	>0.002µCi per gram of waste
Toxic material (include combustion products)	Any toxic chemical or combustion products $\geq$ RQ from Table 302.4, 40 CFR 302; or any other known toxic material (e.g., NIOSH Pocket Guide to Chemical Hazard lists an IDLH)
Carcinogen	Any known carcinogen > RQ from Table 302.4 40, CFR 302 or any other known carcinogen if not treated as toxic material
Biohazard	Any known biohazard where special controls are required
Asphyxiant	Any asphyxiant (i.e., gas at ambient termperature that is denser than air) that could either affect a large number of people or any unsuspecting people
Flammable Material	> 5000lb. of a liquid with a flash point < 100^o F or > 3000 standard ft^3 of a gas with an established lower explosive limit (LEL)
Reactive Material	> 10 lb of a substance with an NFPA reactivity hazard level $\geq$ 2
Explosive Material	Any 49 CFR 173 Division 1.1, 1.2, or 1.3; or > 10 oz of Division 1.4
Electrical Energy	Unusual application not adequately controlled by OSHA (e.g., soil vitrification); $\geq$ 800 volts and 24 ma output; or stored energy $\geq$ 50 joules at 600 volts
Kinetic Energy	High energy (e.g., flywheel or centrifuge type equipment)
High Pressure	3,000 psig or 0.1 lb TNT (1.4 x 10^5 ft-lb$_f$) equivalent energy
Lasers	Any Class IV, any Class III with non-enclosed beam per American National Standards Institute Z-136.1
Potential Energy	Elevated mass with "high" potential energy
Accelerators	Keep (Classify based on DOE Order 5480.25)
X-ray Machines	Any not meeting ANSI N537/NBS123 requirements

3.4 Integrated Evaluation of Facility Hazards and Potential Accidents (Facility Level)

As discussed in Section 2 and shown in Figure 1, there are several opportunities for integrating HA activities at the facility-level. In particular, activities related to the performance of PrHA and nuclear facility safety analysis serve as the primary baseline for establishing a “safe envelope” under which a facility can operate. These HA activities share much in common and present a primary opportunity for streamlining HA activities. This practice is recognized and encouraged by DOE-STD-3009 and DOE-HDBK-1100-96, *DOE Handbook on Chemical Process Hazard Analysis*, where both are required at a particular facility. Integration can be achieved through a single set of hazard/accident analyses and documentation, assuming DOE contractors work with local site management during the initial planning process and agree on the approach and expectations.

More generally, there are several practices related to all facility-level HA activities that can improve cost-effectiveness and reduce technical inconsistencies among HA efforts. The practice addressed in Section 3.1, as related to the use of Teams, is of primary importance. Improving communication among safety disciplines, analysts and facility/project management can not be overemphasized as the most important element to ensuring integration. Not adhering to the practice will result in duplicative efforts and possibly inconsistent assumptions on consequences and necessary controls related to the same set of hazards. This applies to both contractor and DOE organizations and is necessary to ensure that goals and expected HA outcomes are commonly understood and shared among all participants. This practice also must be extended to worker involvement.

Another important practice that improves cost effectiveness of HA activities is the standardization and appropriate use of HA tools and techniques used at a given facility or site. HA techniques vary in sophistication and cost of implementation, and users should ensure techniques are appropriately selected for the condition being analyzed (e.g., a Hazard and Operability Study may be excessive for a non-complex operation such as a waste storage facility). Additionally, the use of a wide variety of HA techniques and tools translates into additional personnel training and procedures that must be provided on their use. This also applies to computer codes used in consequence modeling. Often, emergency planners and safety analyst use different codes, although DOE G-151-1 discourages this practice.

Sources of Information on Integration of Facility Accident Analysis:

- DOE-HDBK-1100-96, “Chemical Process Hazard Analysis”
- DOE-STD-3009, “Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports”
- Center for Chemical Process Safety (CCPS), “Guidelines for Hazard Evaluation Procedures, Second Edition with Worked Examples”

3.5 Streamlining Activity-Level Hazard Analysis

An analysis of individual work activities/tasks (i.e., maintenance, equipment upgrades, etc) is needed in order to understand the potential dangers that workers face during the course of their duties. This evaluation should rely on hazards information collected, as well as findings from facility-level analysis, and should be inclusive of all sources of hazards including hazardous chemicals, excessive physical stresses, radioactive materials, or other potential dangers.

Activity-level hazard analysis should be integrated with work planning and control processes and institutionalized within procedures. An effective approach used at many DOE sites is a work screening process that considers the complexity, personnel experience and potential hazards associated with job tasks. These factors determine the necessary safety disciplines that should be involved in the job hazards analysis process, the level of analysis required, and the documentation (e.g., work permits, etc) required to authorize work.

Several DOE sites have saved considerable resources by using computer-based tools to help automate activity-level hazard screening and analysis. Most of these systems provide electronic linkages to standards and requirements, as well as specific facility and hazards information. Some systems go even further by providing checklists or questions that help guide planners and safety professionals through the hazard analysis process.

While these systems can be valuable tools, they must be used with care so as not to replace sound human judgments and analytical thinking. However, used properly, these systems can enhance communication among various safety disciplines, work planners, and other decision makers. They can also help automate documents and work requirements necessary to plan and authorize work.

Sources of Information on Activity-Level Hazard Analysis:

- DOE-STD-1120-98, *Integration of Environment, Safety and Health into Facility Disposition Activities*
- Hanford Automated Job Hazards Analysis Tool (http://tis.eh.doe.gov/ewp/sites/hanford/AJHA_description0801.pdf)
- Los Alamos National Laboratory Web Based Hazard Analysis Tool Checklist (Specific Contacts and Available Linkages under review)

4.0 References

DOE/EH-0506, Worker Involvement Lessons Learned and Good Practices from INEEL Facility Disposition Activities

DOE/EH-0486, Integrating Safety and Health During Facility Disposition, with Lessons Learned from PUREX

10 CFR 70.62 (Domestic Licensing of Special Nuclear Material)

NUREG-1520, Chapter 3, Integrated Safety Analysis and ISA Summary (http://techconf.llnl.gov/cgi-bin/downloader/Part_70_lib/073-0161.pdf)

DOE HDBK-1100-96, Chemical Process Hazard Analysis

DOE-HDBK-1100-96, “Chemical Process Hazard Analysis”

DOE-STD-3009, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports"

Center for Chemical Process Safety (CCPS), "Guidelines for Hazard Evaluation Procedures, Second Edition with Worked Examples"

DOE-STD-1120-98, *Integration of Environment, Safety and Health into Facility Disposition Activities*

Defense Nuclear Facilities Safety Board, Technical Report-16, *Integrated Safety Management*

Appendix A,
Summary Comparison of
Hazard Analysis Requirements

Hazard Analysis Requirements	**Purpose**	**Expectations**	**Thresholds for Applicability**	**Safety Documentation**	**Integration with Other HA Requirements**
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals; and* **40CFR68.67**, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	Establish process safety management programs for facilities with hazardous chemicals exceeding established thresholds	• Review previous incidents with potential for catastrophic consequences • Identify/analyze chemical process hazards using hazard evaluation technique appropriate for facility complexity (What-If, Checklist, What-If/Checklist, HAZOP, FMEA, or equivalent) • Identify engineering and administrative controls applicable to hazards • Document findings and recommendations and prepare a written schedule for corrective actions • Update PrHA every 5 years	Chemical inventories that exceed OSHA PSM Threshold Quantities and EPA RPM Threshold Quantities	• Process Hazard Analysis Document • Corrective Action Plan • Risk Management Plan	Integration between process hazard analysis and nuclear facility safety analysis is discussed and encouraged in DOE-STD-1027-92, DOE-STD-3009-94, EM-STD-5502, DOE-STD1120-98 and DOE-HDBK-1100-96. Much similarity in EPA, OSHA and nuclear safety analysis requirements. One hazard analysis could satisfy all three requirements
10 CFR 830, *Nuclear Safety Management* *(Note: Also covers DOE Order 5480.23)*	• Prevent or mitigate potential consequences from hazardous/radiologica l material releases • Ensure defense in depth and worker protection measures • Provide a technical basis for authorizing safe operation of nuclear facilities	• Identify inventory of facility hazardous/radiological materials • Perform hazard analysis and classification • Analyze potential accidents and establish engineering and administrative controls • Identify safety-class and safety-significant SSCs • Prepare a Documented Safety Analysis • Update annually	Radiological inventories that exceed Hazard Category 1, 2, or 3 thresholds of DOE-STD-1027-92	• Documented Safety Analysis, or • Basis for Interim Operation, or • Health and Safety Plan, • Technical Safety Requirements	See comments above. • Other potential integration points: • Assumptions and findings from fire hazard analysis • Safety analysis provides sound basis for EIS and emergency management hazard analysis accident assumptions
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	Ensure worker risks associated with hazardous materials are evaluated and communicated to employees at hazardous	• Identify any suspected condition that may be immediately dangerous to life and health of workers • Calculate worker risks associated with hazardous substances and inform employees	Applies to facility/site cleanup activities that are regulated (e.g., CERCLA) and pose a "reasonable possibility for exposure" to workers	Health and Safety Plan	The *DOE Handbook for Occupational Health and Safety During Hazardous Waste Activities*, June 1996, encourages analysts to review safety analysis and process hazard analyses and

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
	waste cleanup sites	inform employees • Determine appropriate site controls and PPE • Prepare health and safety plan			use data as input to preparing Health and Safety Plans.
DOE O 151.1, *Comprehensive Emergency Management System*	Obtain hazards information in order to identify resources, personnel and equipment for emergency hazardous materials program and define a facility's emergency management plan and Emergency Planning Zones	• Identify and screen hazardous chemicals and radiological materials • Analyze potential accident events • Estimate consequences • Update annually	**Chemicals**: Lowest of threshold quantities in 29 1910.119, 40 CFR 68.130, or TPQ in 40 CFR 355 (Use 40CFR302.4 for chemicals not found in stated regulations) **Radiological**: Thresholds given in 10 CFR 30.72, Schedule C	Emergency Planning Hazard Assessment	DOE G 151.1-1 encourages the hazard assessment to make use of facility description and accident scenarios from safety analysis, as well as hazardous material estimates used for other purposes
DOE O 420.1, Facility Safety *(Note: Requires a fire hazards analysis, natural phenomena assessment, and a criticality safety evaluation)*	*Fire Hazards Analysis*. Identify the potential for fire loss (life, monetary and mission) and justify the appropriate fire protection programs and systems to meet the DOE fire protection goals established in DOE Order 420.1.	• Identify fire hazards (e.g., energy sources, building construction, combustibles) • Postulate possible fire accident scenarios • Estimate potential consequences (e.g., maximum credible and possible fire loss) and assess adequacy of controls • Provide recommendations related to any deficiencies	Required for all nuclear facilities, significant new facilities and facilities that present unique or significant fire safety risks	FHA Document	DOE O 420.1 requires that conclusions of the FHA be integrated into the safety analysis. This practice should also apply to chemical operations with the scope of Doe O 420.1

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
	Natural Phenomena Assessment. Ensure that NPH impacts on facility safety are assessed and adequately controlled	• Conduct NPH site investigation using DOE-STD-1022 • Conduct Probabilistic Seismic Hazard Analysis (PSHA) to produce a seismic hazard curve to be used in selecting the design basis earthquake (DBE) for PC-3 and PC-4 SSCs. • Choose DBE and analyze SSC response and necessary controls	Applied on a graded approach depending on facility and system, structure or component Performance Category (see DOE -STD-1021-93)	NPH Document	NPH assessment results must be integrated into safety analysis and evaluated as an accident initiator
	Criticality Safety Program Evaluation. Document the parameters, limits, and controls needed to prevent inadvertent nuclear criticality	• Perform nuclear criticality safety evaluations for normal and abnormal credible accident conditions	Applies when a facility has fissionable nuclides of concern as addressed in Table 4.3-1 of DOE 420.1	CSE document	Integration is only at issue with nuclear safety analysis activities
DOE 440.1A, *Worker Protection Management*	Ensure that workplace hazards and risk of associated worker injury or illness are adequately controlled	• Analyze designs for new facilities and modifications to existing ones, operations and procedures, and equipment, product and services. • Assess worker exposure to chemical, physical, biological, or ergonomic hazards. • Evaluate workplace activities through job hazards analysis	None. Applies to all DOE and contractor activities	• Job Hazards Analysis • Health and Safety Plan • Work Permits • Chemical Hygiene Plan	Oriented primarily at the task or activity level. Facility-level analysis such as process hazard analysis or nuclear safety analysis should be used a major input to worker hazard analysis activities. Conversely, worker hazards analysis may provide insights into facility hazards not adequately analyzed in existing safety analysis or process hazard analysis.
DOE O 451.1A, *National Environmental Policy Act Compliance Program,* and **40 CFR 1502**	Provide the regulators and public with maximum potential environmental and health effects associated with planned work	• Evaluate direct and indirect environmental effects and their significance from proposed DOE actions	EIS required for classes of actions as described in Appendix D to Subpart D of 10 CFR 1021	Environmental Impact Statement	An EIS should rely on analytical assumptions from DSAs or process hazard analyses

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
Environmental Impact Statement; **10 CFR 1021,** *DOE NEPA Procedures*	activities				
10 CFR 850, *Chronic Beryllium Disease Prevention Program*	Ensure that beryllium hazards and potential exposure pathways are identified and controlled	• Analyze existing facility conditions, exposure data, medial surveillance trends, • Identify quantities and forms of beryllium • Identify locations of beryllium materials • Assess exposure potential of planned activities	Presence of beryllium materials or residues	• Chronic Beryllium Disease Prevention Plan • Hazard Assessment Report	Existing hazard analysis documents such as safety analysis should be used as input in surveying beryllium hazard potential
Various Hazard or Activity Specific OHSA Regulations: **29 CFR 1910.146,** *Permit-required Confined Spaces;* **29 CFR 1910.132,** *Personal Protective Equipment;* **29 CFR 1910.94**, *Ventilation*; **29 CFR 1910.1450**, *Occupational Exposure to Hazardous Chemicals in Laboratories*	Ensure that worker hazards are controlled and appropriate personal protective equipment used when appropriate	• Analyze health hazards associated with specific job activities • Measure worker exposures to chemical substances • Identify hazards that should be controlled by personal protective equipment	Regulation specific such as: • Work performed in confined spaces, • Laboratory operations, • Blasting operations	• Chemical Hygiene Plan • Job safety analysis • Work permits • Work packages	OSHA regulations are required by DOE O 440.1A. Activities prescribed by the order are consistent and should not be duplicative of OSHA requirements

Appendix B,
White Paper on Fire Hazards Analysis

"SYNTHESIS OF SAR AND FHA METHODOLOGIES"

A "white paper" developed by representatives of the DOE/contractor safety analysis and fire protection communities.

Introduction

The purpose of this white paper is to attempt to resolve certain misperceptions that appear to exist among some members of the safety analysis and fire protection communities within the Department of Energy (DOE) regarding acceptable methodologies for the preparation of Safety Analysis Reports (SAR) and Fire Hazards Analyses (FHA). The principal misperception is that DOE directives are written in a way that inherently results in an incompatible approach to the development of the analyses required for these documents.

The need for clarification at this time is stimulated, in part, by the amount of time and resources that are continually expended unnecessarily in resolving conflicting methodologies, redundant documentation, and contrary conclusions. An additional impetus is the steady stream of studies[1] that highlight the fact that fire continues to be one of the, if not **the** most, dominant contributor to risk at most of the Department's existing and proposed facilities.

This paper was written by a team of DOE and contractor safety analysts and fire protection engineers as a result of an action item that was discussed during a July 8, 1999, teleconference of the DOE Secretarial Officers Working Group (SOWG) for Reviews of Implementation Plans and Schedules for Safety Analysis Reports (SARs) and Technical Safety Requirements (TSRs).

Background

The principal DOE Directives that address this issue are as follows:

DOE O 420.1, "*Facility Safety*"

DOE Order 5480.23, "*Nuclear Safety Analysis Reports*"

DOE Standard 3009-94, "*Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*"

G-420.1/B-0, "*Implementation Guide for use with DOE Orders 420.1 and 440.1, Fire Safety Program*"

These directives require that both SARs and FHAs be developed for DOE nuclear facilities (FHAs are required for significant non-nuclear facilities as well) under the "graded approach." In other words, the scope and level of detail necessary for each are directly related to the level and significance of risk and the life-cycle phase of the facility. DOE fire safety directives emphasize additionally the flexibility to pursue alternate approaches to fire protection program documentation when justified on the basis of costs versus benefits. The above-referenced Implementation Guide reinforces the need for concerted action by representatives of the various safety disciplines in the development of SARs and FHAs and suggests that a comprehensive SAR would obviate the need for a separate FHA. While all of these directives offer specific criteria for the development of safety basis documentation, none contain criteria that are overtly contradictory.

Program Goals

DOE Order 420.1, *Facility Safety*, establishes the nuclear safety goal[1] that DOE non-reactor nuclear facilities be "designed and constructed so as to assure adequate protection for the public, workers, and the environment from nuclear hazards." Thus, the primary purpose of the SAR is to identify and justify a set of controls "to ensure that a facility can be constructed, operated, maintained, shut down, and decommissioned safety and in compliance with applicable laws and regulations" [DOE 5480.23].

DOE Order 420.1 also establishes the fire protection goals. These are to minimize the potential for:

(1) the occurrence of a fire or related event;

(2) a fire that causes an unacceptable on-site or off-site release of hazardous or radiological material that will threaten the health and safety of employees, the public or the environment;

(3) vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards;

(4) property losses from a fire and related events exceeding defined limits established by DOE; and

(5) Critical process controls and safety class systems being damaged as a result of a fire and related events.

Similarly, the primary purpose of an FHA is to identify the potential for fire loss (life, monetary and mission) and justify the appropriate fire protection programs and systems to meet the DOE fire protection goals established in DOE Order 420.1. While these two purposes are similar, the programmatic goals driving each program are not identical. The differences sometimes result in an appearance that the requirement documents are not in agreement. This paper will demonstrate that the requirement documents are consistent, it

[1] DOE Order 420.1 uses the term objectives. In this paper the term goal is being used to maintain consistency with *The SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, May 1999.

is in their implementation that the inconsistencies and misconceptions are sometimes introduced.

Objectives and Criteria

The Society of Fire Protection Engineers (SFPE) has recently prepared a guide for the preparation of engineered fire protection[2]. This guide has a comprehensive methodology that allows goals to be refined into stakeholder objectives, design objectives and quantified performance criteria. The methods presented in this guide will be used to demonstrate that all of the goals addressed by the SAR are included in the FHA and the FHA includes must address additional goals.

Table 1 lists the goals for the nuclear safety and fire protection programs. The second goal in the fire protection program is the same as the nuclear safety program goal. The first fire protection goal (minimize the potential for fire or related event) is consistent with the nuclear safety goal. Often the controls (e.g., hot work programs) instituted to implement this goal are credited in the SAR. When this occurs, some review mechanism must exist to ensure that changes to the fire protection program will not compromise the SAR conclusions.

The fifth fire protection program goal is consistent with the nuclear safety program goal, however there can be instances where minimizing the potential for fire damage to safety class systems is in excess of the nuclear safety program goals. An example of this would be an interlock that was only required during a process upset event. If the process-upset event and any fire accident were independent, then the SAR would not require the interlock be protected from fire. Fire protection goal 5 would require some level of fire protection. This level of protection should be graded to reflect the importance to safety, the cost of protection, and the cost of replacement. Thus, there will be cases where potential for fire damage to safety class systems is deemed acceptable. In such cases both the FHA and SAR should reflect this decision.

The two remaining fire protection goals (mission continuity and monetary loss protection) are separate from the nuclear safety goal. Often the fire protection features required to accomplish these goals will reduce the nuclear safety risk. When the fire protection features qualify as Safety Class or Safety Significant (SC/SS) the fire protection and nuclear safety programs are perceived as consistent. When a feature is not SC/SS, there is sometimes the mistaken impression that the SAR and FHA are inconsistent. Not every control that reduces the nuclear safety risk to the public need be safety class, nor every control protecting workers need be safety significant. SS/SC controls are those that are considered mandatory to reduce the nuclear safety risk to an acceptable level. In addition to SS/SC controls, DOE requires the identification of Defense in Depth (DiD) items, which are considered additional controls that further reduce the nuclear safety risk. Where the FHA identifies a need for non-SS/SC controls, those controls are good candidates for DiD items. If such an item is not DiD, then it can usually be attributed to the third or fourth fire protection goal.

[2] In fire protection vernacular this is performance-based design.

Methodology

SARs are the cornerstone of the Authorization Basis for most Hazard Category 1, 2 and 3 Nuclear Facilities in the DOE complex. New SARs are prepared to meet DOE Order 5480.23 using the methods described in DOE-STD-3009-94 and is similar to overall process used in preparing an FHA. In preparing a 3009-style SAR a multi-step analytical process is commonly used. The steps in this process are:

Hazard identification that defines inventories of hazardous material and assesses the Facility Hazard Classification,
Hazard analysis that comprehensively characterizes hazards, qualitatively evaluates hazards, and identifies important equipment and administrative controls, and
Accident analysis that quantitatively analyzes accidents of concern.
Functional classification that ranks the importance engineered controls (i.e., Systems, Structures and Components), which maintain facility safety.
Controls selection that establishes the operating limits and programmatic requirements, which maintain facility safety.

An FHA uses a similar logic and starts with hazard identification, however in most instances the remaining steps are accomplished by a demonstration that the facility (both engineered features and administrative programs) are in compliance with the applicable codes (typically the *National Fire Codes*®). When such a method is used, the generic analysis and control selection process used by the technical committee preparing the code, is assumed to be applicable. The use of generic analysis and controls (e.g., *The National Fire Codes*®) often leads to the misconception that the SAR and FHA methodologies are incompatible. When this occurs, the analytical methods must be evaluated. Sometimes the generic methods introduce controls that are not applicable to the situations normally found in nuclear facilities. Also the SAR analysis could be neglecting objectives or hazards that the FHA must address.

Issues

Duplicate Effort - Both SARs and FHAs are required to describe a broad spectrum of facility attributes. (Reference Section 8.b of DOE 5480.23 and Paragraph 4.5 of G-420.1/B-0.) Examples include; site characteristics, facility description, process equipment and operations, hazards, damage potential, safety features and emergency preparedness, among other facets. Doing so in both documents is unnecessarily redundant. DOE requirements and expectations would be met by a comprehensive description in one, with an explicit reference in the other.

Prescriptive Fire Protection Requirements - There is a perception that FHA development criteria in DOE directives preclude the use of analytical approaches based on probabilistic methodologies and modeling. While it is true that G-420.1/B-0 directs that the risks from fire be qualitatively assessed for each fire area, it does not proscribe the use of probability and statistics as well as validated fire models in the ranking or description of fire scenarios within given areas. There is a general recognition, however, that these analytical tools are subject to varying results depending the nature of the underlying assumptions. Thus, the ultimate decision on the nature and extent of fire protection within a given fire area must based on established design criteria as tempered by the judgement and experience of qualified fire protection engineers.

Conflicting Controls - The conclusions of a SAR are often perceived to be at odds with those of the corresponding FHA. In fact, it is not uncommon for a SAR to conclude that fire protection features are not needed to mitigate the consequences of bounding fires. While, under the same circumstances, the FHA will conclude that the same fire protection features are required. The following paragraphs demonstrate several reasons why these discrepancies sometimes occur.

Differing Paradigms – As stated previously, the SARs primary goal is to identify and justify an adequate set of controls for nuclear safety. Thus the nuclear safety analysts must ensure that the analysis and controls can be successfully implemented as Technical Safety Requirements (TSRs) and Operational Safety Requirements (OSRs). The formality in the use and implementation of these documents, sometimes limits the types of controls that can be successfully credited. The DOE fire protection program has historically been based on best industrial and insurance practices (Highly Protected Risk). These practices have been developed over the past 100 years and have been demonstrated to achieve the desired reduction in fire risk. Unfortunately the formality required of nuclear safety programs is sometimes lacking, and thus duplicate protective features, or conflicting assumptions can occur.

The Small Fire – The accidents that are explicitly analyzed in most SARs are severe and most of the effort is focused on demonstrating that the potential consequences will occur at an acceptably low frequency. In most facilities the most severe fires will be at frequencies below 1.0E-3/yr, often approaching 1.0E-6/yr. Since an incipient fire frequency in most nuclear facilities ranges from 0.1 to 1/yr, it is possible that the overall fire risk (worker, monetary, mission, etc.) is dominated by the high frequency fires, rather than the bounding fire that is the dominate nuclear safety fire risk. Thus, the fire protection program may require additional controls, not needed to achieve the appropriate nuclear safety risk.

Independence – As with most engineering efforts there is considerable flexibility in selecting the "best" approach. The definition of "best" includes such non-technical realities as limited budget, tight schedules and available resources (e.g., people). Thus, the SAR and FHA can develop alternate controls strictly because they selected alternate approaches. This promotes the misconception that the FHA and SAR are not compatible. The correct interpretation is that the two documents must be coordinated in their development and their scheduled updates.

Recommendations

- Prior to the development of a SAR and FHA for a given facility, the (DOE and contractor) stakeholders should be clearly defined and then meet to define mutually acceptable assumptions, methodologies, formatting, etc. and to establish a mechanism for the timely resolution of disputes.

- The schedule for the development of the SAR and FHA should be mutually compatible.
- The selection of controls to reduce nuclear safety and other fire risks should be coordinated to ensure that the most effective set of controls are selected.
- The fire protection engineer who is responsible for the development of the FHA should be on the "team" which is developing the SAR.
- Previously developed and (DOE) approved SARs and FHAs should be used as the models for subsequent safety basis documentation. (Refer also the "model" fire hazards analyses in the DOE Fire Protection Handbook. These models can be downloaded from the DOE Fire Protection Web Site at: http://tis.eh.doe.gov/fire/)

Works Cited

[1] D. A. Coutts, M.E. Bowman, C. E. Shogren and M. J. Hitchler, "Fire Risk Implications in Safety Analysis Reports," March, 19, 1999.

Facility Safety. 1996. Washington, DC: Department of Energy. (24 October). DOE O 420.1, Change 2.

Nuclear Safety Analysis Reports. 1994. Washington, DC: Department of Energy. (10 March). DOE 5480.23.

Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports. 1994. Washington, DC: Department of Energy. (July). DOE-STD-3009-94.

B-8

Table 1.—Comparison of Nuclear Safety and Fire Protection Goals, Objectives and Sample Performance Criteria

Goal	Stakeholder Objective	Sample Design Objective	Sample Performance Criteria
Nuclear Safety Program			
DOE non-reactor nuclear facilities are to be "designed and constructed so as to assure adequate protection for the public, workers, and the environment from nuclear hazards."	No significant release of hazardous or radiological material	Limit the off-site doses to avoid deaths	Off-site: 0.5 rem for anticipated events 5 rem for unlikely events 25 rem for extremely unlikely events
Fire Protection Program			
(1) minimize the potential for the occurrence of a fire or related event;	Minimize the number of unwanted fires	Establish a comprehensive fire protection program that includes the controls of combustibles and ignitions sources	Establish a comprehensive fire protection program that includes the controls of combustibles and ignitions sources
(2) minimize the potential for a fire that causes an unacceptable on-site or off-site release of hazardous or radiological material that will threaten the health and safety of employees, the public or the environment	No significant release of hazardous or radiological material	Usually coordinated with SAR design objectives for radiological releases.	Usually coordinated with SAR design objectives for radiological releases.
(3) minimize the potential for vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards	No vital programs shall suffer an interruption greater than 6 months	Customized for individual program.	Customized for individual program.
(4) minimize the potential for property losses from a fire and related events exceeding defined limits established by DOE	Limit most fire losses to $1 million	Prevent flashover in the room of origin for any large structure.	Properties with greater than 5,000 sq. ft. shall have automatic suppression
			Properties with a fire loss potential greater than $1 million shall have automatic suppression
	Limit the potential for fire losses exceeding $25 million	Properties with a fire loss potential greater then $25 million shall have redundant fire protection	Establish fire areas with 2-hour rated construction whenever the MPFL exceeds $25 million.
	Limit the maximum possible fire loss to $50 million	Properties with a MPFL greater than $50 million shall be subdivided with fire walls.	Provide freestanding fire walls to limit the MPFL to $50 million
(5) minimize the potential for critical process controls and safety class systems being damaged as a result of a fire and related events.	Customized for individual program.	Customized for individual program.	Customized for individual program.